

WHAT IS CLAIMED IS:

1. A structure of a reflux fan for an excimer laser apparatus, for circulating laser gas in a chamber by rotation of a fan driven by a motor, comprising:

5 a rotary shaft on which the fan is attached and rotated by a driving force of said motor;

a control type magnetic bearing supporting said rotary shaft in a non-contact manner; and

10 a protective bearing supporting the rotary shaft when said control type magnetic bearing is unable to support said rotary shaft; wherein

said control type magnetic bearing includes

radial magnetic bearings including radial electromagnets arranged at three portions along axial direction and position detection sensors arranged around respective radial electromagnets, and

15 an axial magnetic bearing including one axial electromagnet and at least one permanent magnet;

20 a said axial electromagnet is arranged opposing to one end surface of said rotary shaft, and said permanent magnet is arranged opposing to the other end surface of said rotary shaft; and

among said radial magnetic bearings, the first radial magnetic bearing is arranged close to said axial electromagnet, the second radial magnetic bearing is arranged nearer to one side of the rotary shaft than the permanent magnet arranged opposing to an end surface of said rotary shaft, and the third radial magnetic bearing is arranged between said motor and said fan.

2. The structure of a reflux fan for an excimer laser apparatus according to claim 1, wherein

said protective bearing includes

5 a first protective bearing supporting both axial and radial directions of said rotary shaft, and arranged close to said axial electromagnet and said motor, and

a second protective bearing supporting only the radial direction of said rotary shaft, and arranged close to said the other radial electromagnet.

3. The structure of a reflux fan for an excimer laser apparatus according to claim 2, further comprising

a third protective bearing arranged between said third radial magnetic bearing and said fan, and capable of supporting only the radial direction.

4. The structure of a reflux fan for an excimer laser apparatus according to claim 1, wherein

a soft magnetic material is provided at a portion of said rotary shaft that opposes to said axial electromagnet,

except for said soft magnetic material, said rotary shaft has its diameter made equal to or smaller than each inner diameter of said first radial magnetic bearing, said second magnetic bearing and said third magnetic bearing, from the side of said axial electromagnet to said permanent magnet.

5. The structure of a reflux fan for an excimer laser apparatus according to claim 1, wherein

said radial electromagnet has 8 magnetic poles in a circumferential direction, adjacent two said magnetic poles generate electromagnetic force on the rotary shaft, or has four electromagnets in the circumferential direction and corresponding four magnetic poles in the axial direction and a set of two magnetic poles adjacent in the axial direction exerts electromagnetic force on said rotary shaft, each radial magnetic bearing has two control axes, with each control axis supporting self weight of said rotary shaft.

6. A structure of a reflux fan for an excimer laser apparatus, for circulating laser gas in a chamber by rotation of a fan driven by a motor, comprising:

5 a rotary shaft on which the fan is attached and rotated by a driving force of said motor;

a control type magnetic bearing supporting said rotary shaft in a non-contact manner; and

10 a protective bearing supporting the rotary shaft when said control type magnetic bearing is unable to support said rotary shaft; wherein said control type magnetic bearing includes

radial magnetic bearings including radial electromagnets arranged at two portions along axial direction and position detection sensors arranged around respective radial electromagnets, and

15 an axial magnetic bearing including one axial electromagnet and at least one permanent magnet;

→ said axial electromagnet is arranged opposing to one end surface of said rotary shaft, and said permanent magnet is arranged opposing to the other end surface of said rotary shaft; and

20 of said radial magnetic bearings, one radial magnetic bearing is arranged close to said axial electromagnet, and the other radial magnetic bearing is arranged nearer to one side of the rotary shaft than the permanent magnet arranged opposing to an end surface of said rotary shaft.

7. The structure of a reflux fan for an excimer laser apparatus according to claim 6, wherein

said protective bearing includes

5 a first protective bearing supporting both axial and radial directions of said rotary shaft, and arranged close to said axial electromagnet and said motor, and

a second protective bearing supporting only the radial direction of said rotary shaft, and arranged close to said the other radial electromagnet.

8. The structure of a reflux fan for an excimer laser apparatus according to claim 6, further comprising

a third protective bearing arranged between said motor and said fan.

9. The structure of a reflux fan for an excimer laser apparatus according to claim 6, wherein

a soft magnetic material is provided at a portion of said rotary shaft which opposes to said axial electromagnet,

5 except for said soft magnetic material, said rotary shaft has its diameter made equal to or smaller than each inner diameter of said first radial magnetic bearing and said second radial magnetic bearing from the side of said axial electromagnet to the side of said permanent magnet.

10. A structure of a reflux fan for an excimer laser apparatus, for circulating laser gas in a chamber by rotation of a fan driven by a motor, comprising:

5 a rotary shaft on which the fan is attached and rotated by a driving force of said motor;

a control type magnetic bearing supporting said rotary shaft in a non-contact manner; and

10 a protective bearing supporting the rotary shaft when said control type magnetic bearing is unable to support said rotary shaft; wherein said control type magnetic bearing includes

radial magnetic bearings including radial electromagnets arranged at two portions along axial direction and position detection sensors arranged around respective radial electromagnets, and

15 an axial magnetic bearing including one axial electromagnet and at least one permanent magnet;

said axial electromagnet is arranged opposing to one end surface of said rotary shaft, and said permanent magnet is arranged opposing to the other end surface of said rotary shaft;

20 said motor is arranged close to said axial electromagnet; and of said radial magnetic bearings, one radial magnetic bearing is arranged between said motor and said fan, and the other radial magnetic bearing is arranged nearer to one side of the rotary shaft than the permanent magnet arranged opposing to an end surface of said rotary shaft.

11. A structure of a reflux fan for an excimer laser apparatus, for circulating laser gas in a chamber by rotation of a fan driven by a motor, comprising:

a rotary shaft on which the fan is attached and rotated by a driving force of said motor, and

a magnetic bearing supporting said rotary shaft in a non-contact manner; wherein

said rotary shaft includes an austenitic stainless steel portion, and a magnetic body fixed on a surface of the austenitic stainless steel portion at a position opposing to an electromagnet of said magnetic bearings.

12. The structure of a reflux fan for an excimer laser apparatus according to claim 11, wherein

said rotary shaft with said magnetic body fixed is annealed at a temperature of at least 300°C.

13. The structure of a reflux fan for an excimer laser apparatus according to claim 11, wherein

a material having Ni equivalent given by $(\%Ni + 30 \times \%C + 0.5 \times \%Mn)$ of at least 16 and Cr equivalent given by $(\%Cr + \%Mo + 1.5 \times \%Si + 0.5 \times \%Nb)$ of at least 18 is used for said rotary shaft.

14. A structure of a reflux fan for an excimer laser apparatus, for circulating laser gas in a chamber by rotation of a fan driven by a motor, comprising:

a rotary shaft on which the fan is attached and rotated by a driving force of said motor;

a control type magnetic bearing supporting said rotary shaft in a non-contact manner; and

a protective bearing supporting the rotary shaft when said control type magnetic bearing is unable to support said rotary shaft; wherein

said control type magnetic bearing includes

a radial electromagnet arranged along axial direction of said rotary

shaft and formed by sealing a coil with a metal having corrosion resistance against said laser gas, and

15 a position detection sensor arranged around each of said radial electromagnets, in which a sensor unit is sealed by a metal having corrosion resistance against said laser gas.

015. The structure of a reflux fan for an excimer laser apparatus according to claim 14, wherein

5 said radial magnetic bearing includes
a pair of disk shaped magnetic bodies having a through hole at the center through which said rotary shaft is passed,
a plurality of coils arranged parallel in the axial direction between said pair of magnetic bodies, and
10 a cylindrical member formed of a metal having corrosion resistance against said laser gas and sealing circumference of the through hole of said magnetic bodies.

12 16. The structure of the reflux fan for an excimer laser apparatus according to claim 14, wherein

5 said radial magnetic bearing includes a cylindrical magnetic body having a protrusion therein, and
a coil having outer circumference sealed by a metal having corrosion resistance against said laser gas and inserted to the projection of said magnetic body.

102 17. The structure of a reflux fan for an excimer laser apparatus according to claim 14, wherein

5 said radial magnetic bearing includes
a ring shaped non-magnetic body, and
a coil arranged at every prescribed angle on said non-magnetic body, sealed by a metal tube having corrosion resistance against said laser gas.

0 18. The structure of a reflux fan for an excimer laser apparatus

according to claim 14, wherein

said position sensor includes

5 a disk shaped magnetic body having a through hole to which said rotary shaft is passed at its center, and a plurality of holes formed from outer circumferential surface to the center,

sensor units inserted in said plurality of holes, and

a cylindrical member formed of a metal having corrosion resistance against said laser gas, sealing the circumference of said through hole.

19. The structure of a reflux fan for an excimer laser apparatus according to claim 14, comprising

5 a first housing provided on one side along a direction of the rotary shaft of said chamber, and a second housing provided on the other side; wherein

said radial electromagnets and said position detection sensors include a first radial electromagnet and a first position detection sensor provided in said first housing, and a second radial electromagnet and a second position detection sensor provided in said second housing.

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